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Hydrilla (Hydrilla verticillata Royle) is found in rivers, lakes and streams and impounded bodies of water particularly in calcarious sites. It can tolerate moderate amounts of salinity up to 33% sea water strength. It proliferates under low 0.5-0.75% sunlight and therefore is very competitive with native American species. Large mats are often formed at the water surface, resulting in a monotypic stand of hydrilla. Large concentrations of the plant are found in Florida, Georgia, Louisiana, Texas, Iowa, and California. Hydrilla interferes with fisheries, waterflow, boat traffic and domestic uses of the water.

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THE ECOLOGY AND ENVIRONMENTAL IMPACTS OF HYDRILLA[1]

by

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ABSTRACT

Hydrilla (Hydrilla Verticillata Royle) is found in rivers, lakes and streams and impounded bodies of water particularly in calcarious sites. It can tolerate moderate amounts of salinity up to 33% sea water strength. It proliferates under low 0.5-0.75% sunlight and therefore is very competitive with native American species. Large mats are often formed at the water surface, resulting in monotypic stand of hydrilla. Large concentrations of the plant are found in Florida, Georgia, Louisiana, Texas, Iowa, and California. Hydrilla interferes with fisheries, waterflow, boat traffic and domestic uses of the water.

INTRODUCTION

A water resource will support varied types of aquatic vegetation. The type and density of vegetation depends upon the morphology of the water resource, the nature of the bottom

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1 The findings in this report are not to be construed as an official Department of the Army position unless so designated by other organized documents.

PROGRAM OF RESEARCH[1]

Lake Ocklawaha, Florida which was filled in 1968, covers approximately 5275 ha at a water elevation of 6.1 m msl. The lake is approximately 40 km long by 5 km wide. The reservoir was partially cleared in the area where the 4 m deep Cross Florida Barge Canal traverses the lake. The trees were entirely cleared away along a margin and in other areas the trees were selectively cleared. A total of 2230 ha was totally cleared with the remainder being partially cleared.

In 1969, a study of aquatic vegetation in Lake Ocklawaha showed that 47 species of plants were growing in the lake. Waterhyacinth (Eichhornia crassipes (Mart.) Solms) was the dominant floating aquatic, while southern naiad (Najas guadalupensis (Spreng.) Magnus) and egeria (Egeria densa) were the dominant submersed weeds. The other aquatic plants were found only in small areas of the lake.

In May 1970, a survey was made by a scientist of the U. S. Department of Agriculture Aquatic Weed Laboratory at Fort Lauderdale, Florida, to determine the extent of the aquatic weed problem in the lake. At the that time, aquatic weeds were a minor problem. Spray operations by the U.S. Army Corps of Engineers had resulted in excellent control of the waterhyacinth.

During late summer and early fall of 1970, the submersed weeds southern naiad and egeria became a problem in several areas of the lake; but by late fall, the submersed weed growth was still a minor problem. Local state agencies predict that because of the shallow depth of the lake and its high fertility, aquatic weeds would become a continuous and major problem.

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[1] Abstracted from Blackburn, R.D., Factors affecting the growth and distribution of submersed aquatic weeds in Lake Ocklawaha. Cooperative research report of the Agricultural Research Center, Fort Lauderdale, Florida and the U.S. Army Corps of Engineers, Washington, D.C., 1974, with permission.

In December 1970, the water level in Lake Ocklawaha was dropped 6 m msl exposing 15% of the lake bottom. The water level was scheduled to be returned to its normal level 6.1 m msl in the spring of 1971. This water level fluctuation was to be evaluated as a method of controlling aquatic weeds in Florida impoundments.

In August 1972, the water level in Lake Ocklawaha was dropped an additional 1.7 m msl exposing approximately 60% of the lake bottom. The water level was returned to its August level of 6 m msl in February 1973. The water level fluctuation during this period was for the purpose of forestry management, but it had a dramatic effect on the submersed aquatic vegetation (6, 7, 8, 9).

Study Procedure

Permanent plots 60 m square were established in four different locations in the lake. These plots are permanently marked with metal stakes. The geographical location of each area has been marked on aerial maps of the lake and defined in research reports. The four plots were established in areas of the lake which have different water flow rates, water depths, soil types, and aquatic vegetation.

Biological conditions were studies by the standing crop or biomass method. The standing crop was measured by removing a 0.3 m square area of vegetation from the lake bottom. Three samples were removed from each permanently established plot. Samples were removed by scuba divers clipping the plants in plastic bags as they were collected in the sample area. Plants were removed from the plastic bags, separated by species, counted, measured, and weighed after draining for 5 min. The weighed samples were returned to the plastic bags, stored in ice coolers, and transported to the Fort Lauderdale Laboratory. At Fort Lauderdale, the plant samples were dried, weighed, and analyzed for nitrogen, phosphorous, and potassium.

A liter sample of water was taken from three locations in each of the four plots. A pH measurement, dissolved oxygen, alkalinity, temperature (water and air), and weather conditions were recorded at the time each water sample was collected. A direct-reading colorimeter was used for measuring water color and turbidity. The liter water samples were used for determining the quality of the water in each plot. Most of the water color and turbidity determinations were made by colorimeter, but periodic comparisons were made using other procedures.

The necessity of light for growth of submersed plants probably is one of the most important factors in their distribution. A limnophotometer was used to measure the surface and subsurface illumination from voltaic cells connected to a central control box. One cell was enclosed in a metal case with a window in the top and was used for surface measurement. The other cell, the subsurface unit, was mounted in a watertight case with a window to admit light. Because of the cosine error of the photovoltaic cells, a flashed-opal disk was fitted over the light-sensing area of each cell. Light readings were made by anchoring a boat with the readings. Readings were taken with the submersible cell at the surface, 0.1, 0.3, 0.5, and 1 m depths, and at 1 m intervals thereafter to the lake bottom. Each time readings were taken with the submersible cell, they were taken also with the deck cell. Subsurface readings were recorded only when the surface readings were constant throughout a series of vertical measurements.

DRAWDOWN EFFECTS

The aquatic environment in Lake Ocklawaha has changed tremendously since the lake was filled. Changing of the water level for long periods has had the most profound effect. Environmental factors and macrophyte population changed rapidly after each drawdown. Water drawdown has been used as a lake management tool in other southwestern states but the schedule of drawdown is not a general practice for most Florida lakes.

Water Quality

The fluctuations that occurred appear to be related to seasonal changes and macrophyte growth.

The levels of phosphate in the water have remained nearly constant throughout this sampling period. The reason for the sudden increase in the May sampling cannot be explained at this time. Since there had been little rainfall in the Ocklawaha basin during March and April 1974, most of the water flowing into the lake was supplied by the various springs in or around the lake. The water flowing into the lake from these springs contains high concentrations of phosphate.

Nitrate concentrations at the various sampling stations were directly related to aquatic plant density. Concentrations of nitrate also appeared to be related to seasonal changes which directly affects plant growth. The natural supply of essential nutrients in Lake Ocklawaha is considered to be adequate for vigorous growth of aquatic plants.

Dense growth of submersed aquatic plants has affected the water quality. Alkalinity and calcium carbonate ($CaCO_3$) have changed in relation to the photosynthetic rate of the submersed species. Hydrilla has been shown to affect both measurements by the rapid precipitation of marl ($CaCO_3$) during periods of rapid growth.

Light

It is known that light intensity and spectral composition influences the distribution of submersed aquatic plants. They all show that rooted submersed aquatic plants may colonize suitable substrate down to a depth where light intensity is only 0.5 to 3% of the average intensity at the surface. Lake Ocklawaha has light penetrating to the bottom in all areas of the lake. In May, Secchi disk readings were recorded to a depth of 4 m. The turbidity and color that was created when the lake was reflooded in February 1973 had disappeared by June 1973.

Plant Composition and Density

Prior to the August drawdown, those submersed species having the greatest frequencies of occurrence were egeria, southern naiad, and hydrilla.

A second survey was made on May 28, 1974 to record changes in the growth and spread of hydrilla in the lake. During the 3-week period, hydrilla density had increased and the spread seemed to have been phenomenal in several areas of the lake. The spread may not have been as rapid as recorded because it is assumed that part of the increase was missed during the survey on May 7. Regardless of the reason, it is very evident at this time that hydrilla is the dominant submersed aquatic and will further increase in 1974.

The information collected in this study makes it evident that hydrilla in Lake Ocklawaha was spread by the August 1972 drawdown. During the drawdown, plant fragments were found floating in the open water areas of the lake. Plant fragments broken off in these areas by wave action, water currents, boat propellers, and natural fragmentation floated throughout the main pool.

The competitive relationship or coexistence of hydrilla with other submersed species is new in Lake Ocklawaha and will be important in future years. The water drawdown encouraged the establishment of Ludwigia in the dewatered areas. The drawdown also encouraged the germination of waterhyacinth seeds in the dewatered areas.

Plant Analysis

The productivity of a lake is often reflected in the macrophytes. Ranking growths of rooted macrophytes are usually associated with reservoirs having large areas of shallow water that receive good light penetration. Water analyses are commonly used in assessing the fertility of a lake. In large deep oligotrophic lakes such as analyses may indicate the nutrient supply.

In California, monoecious hydrilla (Hydrilla verticillata (L. f.) Royle) was grown in six soil types amended with two levels of barley straw or peat to test the hypothesis that substrate organic matter would cause reduced growth. Soil type significantly influenced hydrilla dry weight and weight of tubers produced during 8 weeks of growth under outdoor conditions. Also, increased organic matter content (measured as loss on ignition) of the substrate over the range of 1.5 to 27.2% was associated with increased growth of hydrilla. Of 14 substrate properties, multiple regression revealed that the square root of Kjeldahl N and the square root of soil conductivity were the best predictors of hydrilla weight. These results suggest that variability in the responses of rooted aquatic plants to substrate organic matter content reported previously may be partially explained by considering properties of the organic matter, especially nutrient content (6).

CHEMICAL CONTROL OF HYDRILLA

Reproduction capability of the obnoxious submersed aquatic plant hydrilla has established this plant as a menace and serious obstruction to navigation and recreation, water movement for irrigation, drainage and control of floods, and safety of human life. The weed was introduced in Florida in 1960 and now infests some 35,000 to 50,000 acres of Florida waters. Its future spread is unpredictable. In an effort to find a solution, the U.S. Army Corps of Engineers with the cooperation of concerned State and Federal agencies conducted a successful test in the lower Withlacoochee River, using a diquat-copper mix to determine effectiveness, cost, and future potential in moving or turbulent water. The chemical mix proved worthy of future use on selected areas of the problem weed. The cost of treatment is high but its use on hydrilla can be justified in given aquatic sites (5).

The herbicide Sonar also controls hydrilla in most situations. Sonar is the DowElanco registered trademark for products containing the active ingredient fluridone. Sonar aquatic herbicide formulations include an aqueous suspension (Sonar AS) and a slow-release pellet (Sonar SRP). You can apply Sonar to lakes, reservoirs, ponds, drainage canals, irrigation canals and rivers.

Sonar selectively controls undesirable submersed aquatic plants such as hydrilla. Eurasian watermilfoil, fanwort, pondweed (some species) and others. Sonar also controls some emersed and floating weeds.

Unlike contact herbicides that may control every plant in a treated area, Sonar is less active on many native plant species than it is on undesirable, exotic plants. These exotic weeds compete with native plants for nutrients, space and light. Studies show that these native species, crowded out by exotic plant invasion, will return to areas treated with Sonar.

Before applying the herbicide, you must choose the formulation, application technique and time of year when the target plant is most susceptible.

This attention to detail helps ensure removal of undesirable plants with minimal impact on preferred native plants. Certain desirable plants may show symptoms of stress after Sonar applications. But in most cases, these plants recover fully.

NATURAL RESOURCE MANAGEMENT

The best vegetation management strategies and methods are selective. This means that with consistent application, a particular strategy or method will reduce specific plant populations in favor of encouraging another.

That makes it critical to understand each plant's characteristics and the role it plays in a particular natural water resource. This must be understood before you implement the plan. If you favor one plant species or plant group over another, it should possess certain positive traits, or at least be neutral, in regard to the predominant uses. No one is satisfied when you merely exchange one problem for another.

Certain plant species or plant groups exhibit unique habits or growth traits that benefit some lake uses, and are at least tolerable for other uses. These traits usually relate to the plant or plant group's size and shape. We refer to this as plant community architecture.

For example, areas near a stream inflow may support vertical plant growth, which filters suspended sediments, and thereby protects the rest of the lake. Taller species with open architectures and patchy growth habits make excellent habitat for fisheries. They also produce "edge effect" for fishing.

This concept — protecting certain aquatic plant species — can be a difficult one to "sell". Most managers understand, however, that you can keep vegetation our of only a truly dead natural water resource.

The prudent lake manager selects plant species that are maintainable at a reasonable cost, and benefit — or do not interfere with — most uses. The basic rationale: A natural water resource will support some form of plant growth, so the plan should provide direction for managing this growth using acceptable methods.

Although many people believe ecological issues primarily shape the plan, it is sociological issues that get the whole process going. The planning process usually begins when people perceive a natural water resource is not meeting their expectations.

People are drawn to water. They enjoy it and use it for countless purposes. The term "multi-use" resource often describes lakes and reservoirs that satisfy a variety of user groups' expectations.

Unfortunately, not all user groups can be completely satisfied. Conflicts of interest are sure to arise. A well-developed plan may not resolve these conflicts, but can serve as a vehicle of compromise, or at least understanding. For this reason, the plan should explicitly identify user conflicts, if present.

Some conflicts seem inevitable when people gather to resolve a lake-management problem. However, several excellent sources of information on forming and operating effective lake associations may help.

The plan should contain vegetation management cost estimates, and can suggest possible funding sources. You may obtain funding from various agencies and sources, depending on your region of the country and your proposed approach. It usually falls on a lake association leader's shoulders to secure this funding.

Often, monies are collected by voluntary contributions. Some states have statutes that permit created special assessment districts to collect monies for aquatic vegetation management.

Occasionally, you'll discover federal funding for projects. These usually involve matching funds, meaning the local association must raise an amount of funding equal to the federal portion. You should be aware, however, that federal government grants may include stipulations about conducting fairly detailed feasibility studies (3).

SUMMARY AND CONCLUSIONS

The submersed aquatic vegetation in Lake Ocklawaha changed dramatically in 1974. The dominant submersed vegetation in 1970 was southern naiad (Najas guadalupensis), coontail (Ceratophyllum demersum) in 1973, and hydrilla (Hydrilla verticillata) in 1974. The water level drawdown during August, 1972 to February, 1973 played a major role in the ecological shift to hydrilla.

Although various research studies have shown the variability in the growth and proliferation of hydrilla may be due to a number of factors, the nutrient quality of the substrate organic matter is found to be the most important.

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